Serious games in surgical education
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Appraisal of face and content validity of a serious game improving situation awareness in surgical training

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ABSTRACT

**Background:** Equipment-related malfunctions during minimally-invasive surgery (MIS) are common and threaten patient safety. As they occur in the periphery of the surgeon’s vision, the surgical team requires sufficient situational awareness to respond timely. A serious game was developed to train surgical residents to deal with equipment-related errors. This study investigated to which extent surgical educators and trainees would accept a serious game as training method.

**Methods:** A cross-sectional survey was conducted amongst 45 surgeons, surgical residents and medical students, who played the serious game at a scientific convention. The questionnaire contained statements on perceived realism, usefulness, teaching capability, user experience and application toward surgical training. Results were analyzed according to participants’ MIS experience (‘expert’, ‘intermediate’, and ‘novice’).

**Results:** The majority found that important medical constructs were represented realistically (64.4 – 88.9%) and indicated the game to be particularly useful for training OR nurses and surgical residents (75–86%). Both educators and trainees found the game to be useful for surgical training (53%). Serious gaming was viewed as positive (78%), challenging (60%) and 66% would play the game in their leisurely time. Licensed surgeons perceived the game more frequently as boring than trainees (23.5% versus 6.7% and 8.3%, \(p = 0.045\)).

**Conclusion:** This is the first study to show acceptance of a serious game as training format in surgical training by educators and trainees. Future research should investigate whether the serious game indeed improves problem-solving and situational awareness in the OR.
INTRODUCTION

The use of complex technological and electronic equipment has allowed great progress in minimally invasive surgery (MIS), but has also resulted in a heightened mental workload for the surgeon. High mental workload may lead to errors as the untrained human brain has limited capability of recognizing alterations or unexpected events under stressful circumstances, even if they occur in plain sight. Perception is a selective process that focuses mainly on potentially interesting objects in the visual field whilst largely ignoring the uninteresting or unexpected, rightfully or not. These processes are referred to as inattention and change blindness and account for a delayed or inaccurate recognition of potentially harmful events in the OR. As a result, equipment failure may either be ignored or misinterpreted, as well as changes in patients' physiological parameters. Studies show that equipment failure occurs frequently in MIS, leading to delays in operating time and complications to patients with clinical consequences.

The adaptive coupling between humans and their environment during the performance of a complex task is referred to as situational awareness. An observational study showed that surgeons with high levels of situational awareness are less likely to make technical errors during laparoscopic cholecystectomies. Training surgical residents in dealing with equipment-related problems and other non-routine events, is thought to reduce their mental workload during their first procedures, when they need to use most of their mental capacity to focus on the procedure itself. This will most likely result in better recognition and identification of relevant changes in the periphery of their focus, reducing inattention- and change blindness.

Serious games are computer applications that offer a challenging and fun experience to the player, while simultaneously providing educational content in a subtle ‘stealthy’ fashion. A serious game mimics a simulation in that it provides a simulated experience of reality. An important surplus of serious gaming is the abstracted ‘game layer’. The game layer aims at keeping players engaged and immersed in the serious game in order to increase their voluntary adherence to training. Because educational content such as situational awareness is out of direct surgical focus, it could be perceived as uninteresting or irrelevant by trainees and even by surgical educators. A serious game was designed to train surgical trainees in recognizing and dealing with equipment-related problems in MIS.

To date, no evidence is reported on the acceptance of serious gaming by surgical trainees and surgical educators with regard to surgical training. This study assessed to which extent educators and trainees would accept serious gaming to improve situational awareness as useful and relevant to MIS training.
METHODS

Participants

A consecutive cohort of 45 surgeons, surgical residents and medical students with an interest in surgery with no previous exposure to the serious game were recruited on voluntary base during the annual convention of the Dutch Surgical Society (Nederlandse Vereniging voor Heelkunde, May 30th–31st, 2013). In total, 50 persons played the serious game and 5 participants were excluded because they did not have a medical background.

The participants were introduced to the serious game on a laptop computer and received a hands-on instruction by trained instructors, after which they played four three-minute sessions. Then, the participants completed a questionnaire. The participants’ opinions were compared between the expert group (defined as having performed >100 MIS procedures as primary surgeon), intermediate level group (defined as having performed 1-99 MIS procedures as primary surgeon) and novice group (defined as having no experience with MIS). A sample size calculation was not performed due to the nature of the study.
Serious Game

The serious game was developed for surgical residents specifically, aiming to educate them to (1) identify important elements from the surroundings in the operating room (OR) unrelated to the procedure itself, and o (2) solve the problems correctly and efficiently. The serious game (Weirdbeard B.V., Amsterdam, The Netherlands) is fitted to smartphones and tablets and is based on a popular entertainment game. This game has little to do with surgery, but aims to trigger the learner’s intrinsic motivation to play and keep playing. The educational content included the laparoscopic tower’s screen and lighting problems, gas transport problems, electrosurgical problems and specific complications related to MIS (Table 1). This was virtually embedded in the entertainment game (Figure 1, left). While the player plays the game, signals occur signifying specific equipment failure scenarios (Figure 1, centre). The game’s screen reacts to the screen and lighting, the visibility reacts to the insufflation, moving the blocks reacts to the electrosurgical unit and realistic auditory alarms could signify pathophysiological complications or malfunctions.

As soon as the player suspects a malfunction or complication, he or she stops the game by pressing ‘stop’, after which he or she enters the trouble-shooting mode (Figure 1, right). This depicts a simulated laparoscopic tower. The player should diagnose the problem and correct the issue at hand. The players’ performance in problem recognition and problem solving are assessed (proportions of problems recognized and solved, time required, and amount of correct and incorrect diagnostic steps). The player receives feedback on his or her actions.

<table>
<thead>
<tr>
<th>Screen / Lighting</th>
<th>Gas transport / pneumoperitoneum</th>
<th>Electrosurgery</th>
<th>Pathophysiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blurred screen</td>
<td>Intra-abdominal pressure too high</td>
<td>Electrosurgery alarm</td>
<td>Desaturation</td>
</tr>
<tr>
<td>Condensation on screen</td>
<td>Insufflation insufficient</td>
<td>Electrocautery does not function</td>
<td>Hypotension</td>
</tr>
<tr>
<td>Flashing screen</td>
<td>Obstructed gas chain</td>
<td>Electrocautery insufficient</td>
<td></td>
</tr>
<tr>
<td>Moving image</td>
<td>Empty gas supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow colouring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green colouring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red colouring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darkened screen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light screen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black screen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘No signal’ sign</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoke on screen</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. List of problem scenarios included in the serious game content, grouped by equipment. Problems can have multiple causes.
By embedding equipment failure scenarios in an alternate activity, the ‘real’ operating room situation is simulated, in which trouble occurs outside the visual field from the surgeon itself. Educational content was derived from the Fundamentals of Laparoscopic Surgery course\textsuperscript{13}. The scenarios were checked and corrected by two independent laparoscopic surgeons and five MIS equipment specialists. They were given in written form with correct solutions, leaving content experts to choose between “valid” and “invalid”.

**Questionnaire**

The questionnaire was accessed through Google Docs (Google Inc. Mountain View, CA, United States) and contained twelve items on demographic characteristics, seven statements on realism of important medical aspects (MIS equipment, problem scenarios). Six statements questioned the serious game’s educational value and six statements concerned its usefulness for different user groups. Seven statements questioned user experience and seven statements on use in surgical curricula.

The statements were evaluated on a five-point Likert scale, in which 1 related to ‘fully disagree’, 3 to ‘neutral’ and 5 to ‘fully agree’. A median value >3.0 was viewed as a positive response to the statement, <3.0 a negative response. Additionally, participants could clarify their opinion through an open textbox per topic.

**Statistical analysis**

Measurements were recorded and analyzed using the IBM Statistical Package for Social Sciences (SPSS 19, IBM Corporation, Armonk, NY, United States). Nonparametric tests were used to calculate differences between user groups; statistical significance was considered at \( p < 0.05 \).

**RESULTS**

**Demographic characteristics**

Fourteen licensed surgeons, twenty-five surgical residents and six medical students with an interest in surgery participated in the study (Table 2). Participants were based at different hospitals in The Netherlands. Of the surgeons, 13 specialized in general surgery and 1 in vascular surgery. The mean number of years registered was 12.5 years (SD 8.4). Of the residents, 88\% specialized in general surgery, 8\% in urology and 4\% in plastic surgery. The participants were grouped according to their experience with MIS using abovementioned criteria. All were included in the analysis, although one participant from the expert group was lost due to technical failure of the questionnaire.
Characteristics | Novice (No experience in MIS) | Intermediate (1-99 MIS procedures) | Expert (>100 MIS procedures)
--- | --- | --- | ---
Group size | 12 | 15 | 18
Sex | M (%) | 50 | 66 | 89
 | F (%) | 50 | 33 | 11
Age | mean, SE | 25.8 (± 0.7) | 31.9 (± 0.8) | 44.6 (± 2.3)
Function | Student | 6 | 0 | 0
 | Resident | 6 | 14 | 5
 | Specialist | 0 | 1 | 13
Videogame experience | Current (%) | 66 | 53 | 22
 | Past (%) | 17 | 7 | 17
Laparoscopic equipment training | Basic lap course (%) | 8 | 87 | 61
 | Advanced lap course (%) | 0 | 0 | 6

Table 2. Demographic characteristics per study group, measured in numbers unless stated otherwise. SE = standard error; MIS = Minimally Invasive Surgery

Representation of medical constructs

Table 3 refers to the participants’ opinions on realism of medical constructs that were incorporated in the serious game. In total, 88.9% found the MIS equipment representation to be realistic, 84.4% the displays and parameters on the equipment, 75.9% the auditory signals and 66.7% the visual signals. The problem scenarios were viewed to be realistic by 64.4%, and feedback by 64.4%. Of the participants, 48.9% found solving problems to be realistic, 24.4% did not. There were no significant differences among the groups. The open comments indicated that two participants indicated lack of realism as a problem, and two participants indicated the displays were not adequately altered during a problem.

| Realistic representation | Novice (n=12) | Intermediate (n=15) | Expert (n=18) | P*
--- | --- | --- | --- | ---
 | Median | P25 | P75 | Median | P25 | P75 | Median | P25 | P75
Laparoscopic tower | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | NS
Display parameters | 4.00 | 3.25 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | NS
Auditory cues | 4.00 | 4.00 | 4.00 | 4.00 | 3.00 | 4.00 | 4.00 | 3.00 | 4.00 | NS
Visual cues | 4.00 | 4.00 | 4.00 | 4.00 | 3.00 | 4.00 | 3.50 | 2.00 | 4.00 | NS
Problem scenarios | 4.00 | 3.00 | 4.00 | 4.00 | 4.00 | 4.00 | 3.50 | 2.00 | 4.00 | NS
Solving problems | 4.00 | 3.00 | 4.00 | 3.00 | 2.00 | 4.00 | 3.00 | 2.00 | 4.00 | NS
Feedback | 4.00 | 3.00 | 4.00 | 4.00 | 3.00 | 4.00 | 4.00 | 2.75 | 4.00 | NS

Table 3. Opinions on representation of important medical constructs.

* Kruskal Wallis test.
Teaching capability

Table 4 refers to the perceived teaching capability of the serious game. Of the participants, 48.9% found the serious game to be useful for functioning in the laparoscopic environment, 28.9% did not. Furthermore, 93.4% thought that the serious game would enhance the players’ awareness of equipment malfunctions, 86.6% their problem recognition capabilities and 71.1% their problem solving capabilities. In total, 48.9% agreed the game to enhance the players’ environment perception, 22.2% disagreed. The game was thought to enhance overall situational awareness by 62.2%. No significant differences between the groups were observed.

Of the participants, 80% found the serious game to be useful for teaching medical students, 84.4% for OR nurses, 75.6% for interns, and 75.6% for surgical residents. In total, 35.6% thought it to be useful for Fellows in MIS and 33.3% for licensed surgeons. There were no significant differences between the groups. The open comments indicated that three participants thought lack in realism to be a problem to the teaching capability of the serious game. One participant indicated the game to be too specific for students, and fellows. Laparoscopic surgeons were expected to know the content.

<table>
<thead>
<tr>
<th>Usefulness for learning</th>
<th>Novice (n=12)</th>
<th>Intermediate (n=15)</th>
<th>Expert† (n=18)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>P25</td>
<td>P75</td>
<td>Median</td>
</tr>
<tr>
<td>To Function in Laparoscopic Environment</td>
<td>3,00</td>
<td>2,00</td>
<td>4,00</td>
<td>4,00</td>
</tr>
<tr>
<td>Problem Awareness</td>
<td>4,00</td>
<td>4,00</td>
<td>5,00</td>
<td>4,00</td>
</tr>
<tr>
<td>Problem recognition</td>
<td>4,00</td>
<td>4,00</td>
<td>4,75</td>
<td>4,00</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
</tr>
<tr>
<td>Perception of environment</td>
<td>3,50</td>
<td>2,00</td>
<td>4,00</td>
<td>3,00</td>
</tr>
<tr>
<td>Situation Awareness</td>
<td>4,00</td>
<td>3,00</td>
<td>4,00</td>
<td>4,00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Usefulness for teaching</th>
<th></th>
<th></th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>Students</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>3,50</td>
<td>4,00</td>
<td>NS</td>
</tr>
<tr>
<td>OR nurses</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>3,50</td>
<td>4,00</td>
<td>NS</td>
</tr>
<tr>
<td>Residents (not-in-training)</td>
<td>4,00</td>
<td>2,25</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>3,50</td>
<td>4,00</td>
<td>NS</td>
</tr>
<tr>
<td>Residents (in-training)</td>
<td>4,00</td>
<td>3,25</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>4,00</td>
<td>3,00</td>
<td>4,50</td>
<td>NS</td>
</tr>
<tr>
<td>Fellows (MIS)</td>
<td>3,00</td>
<td>2,25</td>
<td>4,00</td>
<td>3,00</td>
<td>2,00</td>
<td>4,00</td>
<td>3,00</td>
<td>2,00</td>
<td>4,00</td>
<td>NS</td>
</tr>
<tr>
<td>Surgeons</td>
<td>3,00</td>
<td>2,25</td>
<td>4,00</td>
<td>3,00</td>
<td>2,00</td>
<td>4,00</td>
<td>3,00</td>
<td>2,00</td>
<td>4,00</td>
<td>NS</td>
</tr>
</tbody>
</table>

Table 4. Opinions on the serious games usefulness for teaching different skills and different user groups.

* = Kruskal Wallis test.
† = 1 participant lost follow-up due to technical problems
User experience

Table 5 refers to the user experience of the participants when playing the serious game. In total, 82.2% found the game to be pleasant, 77.8% funny, 60.0% challenging, and 17.8% addictive. Of the participants, 33.3% found it to be frustrating, 51.1% did not. None found the experience to be repulsive and 13.3% found the serious game boring. Experts found it significantly more boring than other groups (23.5% versus 6.7% and 8.3%, \( p = 0.045 \)). Open comments revealed two participants who explicitly indicated it to be an attractive way to learn about malfunctioning equipment.

<table>
<thead>
<tr>
<th>User Experience</th>
<th>Novice (n=12)</th>
<th>Intermediate (n=15)</th>
<th>Expert (n=17)†</th>
<th>( P^* )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median P25 P75</td>
<td>Median P25 P75</td>
<td>Median P25 P75</td>
<td></td>
</tr>
<tr>
<td>Pleasant</td>
<td>4,00 3,25 4,00</td>
<td>4,00 4,00 4,00</td>
<td>4,00 4,00 4,00</td>
<td>NS</td>
</tr>
<tr>
<td>Funny</td>
<td>4,00 4,00 4,00</td>
<td>4,00 4,00 4,00</td>
<td>4,00 4,00 4,00</td>
<td>NS</td>
</tr>
<tr>
<td>Frustrating</td>
<td>2,50 2,00 4,00</td>
<td>2,00 2,00 4,00</td>
<td>3,00 2,00 4,00</td>
<td>NS</td>
</tr>
<tr>
<td>Challenging</td>
<td>3,50 3,00 4,00</td>
<td>4,00 3,00 4,00</td>
<td>4,00 2,50 4,00</td>
<td>NS</td>
</tr>
<tr>
<td>Repulsive</td>
<td>2,00 1,00 3,00</td>
<td>2,00 2,00 3,00</td>
<td>2,00 1,00 2,50</td>
<td>NS</td>
</tr>
<tr>
<td>Addictive</td>
<td>3,00 2,00 4,00</td>
<td>3,00 2,00 3,00</td>
<td>2,00 1,50 3,00</td>
<td>NS</td>
</tr>
<tr>
<td>Boring</td>
<td>2,00 1,25 2,00</td>
<td>2,00 2,00 2,00</td>
<td>2,00 2,00 3,50</td>
<td>0,045‡</td>
</tr>
</tbody>
</table>

Table 5. User gameplay experience.
* Kruskal Wallis test; † 1 participant lost follow-up due to technical problems; ‡ Statistically significant difference between Novice and Expert groups

Surgical training

Table 6 refers to the opinions on the applicability of the serious game in regular surgical teaching. Of the participants, 13.3% considered the level of difficulty too low; 6.7% too high. Furthermore, 53.3% thought it to fit into the regular surgical curriculum, 77.8% thought it could be played outside the official curriculum. Only 6.6% thought that it should be an obligatory part of the curriculum. In total, 66.6% would download the game. There were no significant differences between the groups.

DISCUSSION

This cross-sectional study shows that surgeons and surgical residents from multiple institutions in the Netherlands have a clear positive opinion towards applying serious games in surgical residency training. Serious gaming is believed to be ‘the next big thing’ in medical education. Residents frequently access apps and games on mobile devices in order to gain knowledge or merely to spend their leisurely time. Over half the physicians and almost 70% of the residents use smartphone apps and mobile technol-
Results are in conformity with other studies that generally show postgraduate medical trainees to have a positive opinion regarding virtual reality applications in postgraduate education\textsuperscript{15,16}. This study is the first to report on the acceptance of serious games in surgical training\textsuperscript{9}, revealing positive opinions. Whereas it represents a novel teaching modality in surgery, the system’s face validity is an important step\textsuperscript{17}.

The usefulness of videogames to education has gained acknowledgement in recent decades\textsuperscript{11} and has found its way into surgical training\textsuperscript{9}. Rosser and colleagues showed that visuomotor skills in laparoscopy are correlated to playing commercially available videogames on well-known game consoles\textsuperscript{18}. New generations are used to the advantages of gaining knowledge trough digital portals. Residents currently spend more time playing videogames than reading books\textsuperscript{19}. This correlates to the high percentage of videogame experience in novice and intermediate groups in this study (83% and 60%, versus 39% in the expert group). These habits therefore call for a different instructional approach\textsuperscript{19}. To date, no scientific results are available on the issue of embedded use of smart strategies such as serious gaming in surgical education\textsuperscript{9,20}.

Our study describes a novel stand-alone off-site instructional tool to improve the situational awareness of inexperienced surgical trainees. Problems related to equipment occur often during MIS\textsuperscript{4}, mostly outside the surgeon’s direct area of focus, which is the

\begin{table}
\centering
\begin{tabular}{|l|c|c|c|c|c|c|c|c|}
\hline
\textbf{Applicability} & \textbf{Novice} & & \textbf{Intermediate} & & \textbf{Expert} & & \textbf{P*} \\
 & \textit{(n=12)} & & \textit{(n=15)} & & \textit{(n=16)} & & \\
 & Median & P25 & P75 & Median & P25 & P75 & Median & P25 & P75 \\
\hline
Level too low & 2,00 & 2,00 & 3,00 & 2,00 & 2,00 & 3,00 & 2,00 & 2,00 & 3,00 & NS \\
Level too high & 2,00 & 2,00 & 3,00 & 2,00 & 2,00 & 3,00 & 2,50 & 2,00 & 3,00 & NS \\
Improves functioning in MIS OR & 4,00 & 2,00 & 4,00 & 4,00 & 3,00 & 4,00 & 3,00 & 2,25 & 4,00 & NS \\
Fits into regular surgical curriculum & 4,00 & 4,00 & 4,00 & 4,00 & 4,00 & 4,00 & 4,00 & 3,25 & 4,00 & NS \\
Fits outside surgical curriculum & 2,00 & 2,00 & 3,00 & 2,00 & 2,00 & 3,00 & 3,50 & 2,00 & 4,00 & NS \\
No interest in playing the SG & 2,00 & 2,00 & 3,00 & 2,00 & 2,00 & 3,00 & 3,00 & 2,00 & 3,00 & NS \\
Should be part of surgical curriculum & 4,00 & 3,25 & 4,00 & 4,00 & 4,00 & 5,00 & 4,00 & 2,00 & 4,00 & NS \\
Would download SG for free & 2,50 & 2,00 & 4,00 & 4,00 & 2,00 & 4,00 & 2,00 & 1,00 & 3,75 & NS \\
Would download SG for 1E & 2,00 & 2,00 & 2,00 & 2,00 & 2,00 & 3,00 & 2,00 & 1,00 & 3,00 & NS \\
Would download SG for 5E & & & & & & & & & & \\
\hline
\end{tabular}
\caption{Opinions on the applicability in surgical teaching.}
\end{table}

\textit{MIS} = minimally invasive surgery; \textit{OR} = operating room; \textit{SG} = serious game

* Kruskal Wallis test.
† 1 participant lost follow-up due to technical problems during assessment
surgical field. To improve situational awareness in the OR, operating team should train to recognize and deal with ‘non-routine events’ during routine procedures. This situational awareness is currently trained mostly “on the job”, during which patients are at unnecessary risk. Moreover, significant knowledge deficiencies on resolving issues with MIS equipment and surroundings frequently exist after regular skills training, even in experienced laparoscopic surgeons. Whereas situation awareness is part of a team’s performance in the OR, curriculum development on non-technical skills in the OR should include the complete OR team.

These results show that both residents and educators are likely to accept serious gaming as a format for training skills in surgery. The traditional view in surgical training is that well-designed training environments require full representations of the real OR. Several expert participants in our study in fact shared this view. Evidence however indicates that the level of realism of the construct in the simulation (referred to as physical fidelity) is not a necessary precondition to allow skills transfer. As long as the relevant elements in the decision-making process of the educational construct are represented realistically (referred to as functional fidelity), the simulation can still induce learning in trainees. The level of immersion (players feeling of presence and control in the simulation), challenge and acceptance of the instrument are more important for skills transfer than physical representation.

Limitations

Limitations and potential sources of bias to the study include the following. First, the participants’ voluntary participation could have introduced a selection bias. However, the sample’s demographic characteristics is in conformity with the target population. Gender differences correspond to gender differences between specialists and medical students, whereas in The Netherlands over two-thirds are female. Age differences are as may be expected due to stratification on experience. Selection bias does not appear to have influenced intergroup opinion differences, but may have positively influenced the cohort as a whole. However, results correspond to the positive opinions of surgical postgraduate trainees on other types of virtual reality based training methods.

Next, mere attention towards the subject could have positively influenced participants’ opinions (Hawthorne effect). Especially lesser-experienced participants are susceptible to this phenomenon. It does not appear to be of great influence to intergroup differences, as no significant differences are seen between groups for all items but one.

Thirdly, participants could be influenced by survey questioners’ enthusiasm (Pygmalion effect). To reduce this, questioners were not affiliated to the game developer and the survey was completed online anonymously.

Finally, the application of Likert-scales could introduce lack of clarity and ambiguity concerning individual questionnaire items. In the survey’s design, many different
definitions were therefore given per construct (e.g. “situational awareness”, “problem awareness” and “perception of environment”), as well as conflicting items (“challenging” versus “boring”). However, this source of bias is hard to exclude.

Conclusions

Results of our study show positive attitudes from educators and trainees from different surgical centers regarding acceptability and use of serious gaming in surgical curricula. These results strengthen legitimacy of serious games for surgical educational curricula. Research is required on novices’ learning curves on the serious game and transfer of problem-solving abilities of game-trained residents in the reality before it’s use is justified, customary to validation standards for instructional tools.

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